PATENT SPECIFICATION

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(54) MAGNETIC CORE FOR A POLYPHASE TRANSFORMER

(71) We, UNELEC, a French Corporation, of 14, rue de la Baume, 75008 Paris, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a magnetic core for a polyphase transformer.

According to the invention there is provided a magnetic core for a polyphase transformer, comprising a plurality of sheets of core material which are arranged in stacked layers to provide a core structure, each layer comprising limbs radiating outwardly from an axis of the core extending in the direction of stacking and a yoke connecting the outer ends of the limbs, and the respective layers being formed by an assembly of abutting sheets so arranged that, for any two adjacent layers, no joint in either layer between abutting sheets coincides with any such joint in the other layer.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings in which:

Figure 1 is a plan view of one layer of a core structure of one form of magnetic core in accordance with the invention, the layer comprising abutting steel sheets and the Figure showing one possible layout for these sheets;

Figure 2 shows the stacking of three successive layers of Figure 1, one above another;

Figures 3, 4 and 5, 6 show two other arrangements for the steel sheets in plan view;

Figure 7 shows a completed magnetic core on which the windings have been installed and which is disposed within a cylindrical casing; and

Figures 8 and 9 show two further shapes for the casing.

In all these Figures, the magnetic core is for a three phase transformer.

The magnetic core comprises a number of sheets of core material (steel) which are arranged in layers stacked one above another to provide a core structure, one of the layers being shown in Figures 1,3 and 5. As can be seen, each layer is formed by an assembly of coplanar abutting sheets and comprises three limbs 1,2,3 which radiate outwardly from the central axis 8 of the magnetic core extending in the direction of stacking with the axes 4,5,6 respectively of the limbs forming an angle of 120° with one another, and a yoke 7 which connects the outer ends of the limbs and comprises arms in the form of steel sheets. All the sheets of each layer have their axes situated in a common plane and the cross-sectional area of the yoke is preferably $\sqrt{3}$ times smaller than the cross-sectional area of each limb.

The yoke is shown to have the shape of a hexagon but it need not necessarily have that shape. Furthermore, the hexagonal shape is irregular but the angle between the sheets of each pair of sheets forming the yoke is, to great advantage, 120° in every case.

The magnetic core is thus constituted by a vertical stack of successive layers of horizontal steel sheets. Each layer (of which three different examples are shown in Figures 1,3 and 5 respectively) is constituted by the juxtaposing of a certain number of steel sheets which have previously been cut out and annealed. In the example in Figure 1, the layer comprises eleven previously cut out steel sheets, whereas in the case of Figures 3 and 5 nine sheets are

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employed.

The complete core comprises a stack of successive layers. The layers comprise identical arrangements of steel sheets but the orientation of each arrangement about the axis 8 varies from layer to layer, each layer being displaced through 120° relatively to the or each neighbouring layer. Thus, the arrangement of the sheets is such that, for any two adjacent layers, no joint in either layer coincides with any such joint in the other layer. Figures 2,4 and 6 show three examples each corresponding to the stacking of three layers such as are shown in Figures 1,3 and 5 respectively. In Figures 2,4 and 6, one of the layers is indicated by a continuous line, the second by a dotted line and the third as an intermittent line.

The magnetic cores disclosed have the advantage of having a magnetic neutral point at the point 8.

The magnetic core is easy to produce, since it consists of a stack of cut out steel sheets, the cutting out of sheet steel being a technique used every day and, generally speaking, the power limit to the carrying capacity of the transformer is above the maximum power which the transformer is required to handle.

Figure 7 shows a magnetic core such as that described with reference to Figures 1 and 2, Figures 3 and 4 and Figures 5 and 6, on which winding assemblies have been installed, one of these winding assemblies being shown in a cutaway view.

The cutaway view of the winding assembly in question shows a low-voltage winding 8′, a medium-voltage winding 9 and an insulating screen 10 arranged between the low-voltage winding 8′ and the medium-voltage winding 9. Screens 11 and 12 are arranged on the one hand between adjacent winding assemblies and on the other hand between the winding assemblies and the yokes.

It will be observed that the disclosed construction provides very large vertical passageways 13, 14 which make it possible to ensure good cooling of the winding assemblies by forced flow of a dielectric fluid.

The core is placed within a cylindrical transformer casing 15 but the casing 15 may have other shapes, for example a rectangular shape as in Figure 8 or else a shape more or less matching the external geometry of the magnetic core as in Figure 9.

A compact transformer enabling an economy of material of the order of 15% for the copper of the windings and the steel sheet as a whole, in relation to a typical conventional transformer of similar power rating having superposed horizontal coils, may thus be obtained. Moreover, the geometry of the transformer ensures excellent distribution of the magnetic flux.

Furthermore, as the axes of the windings are horizontal and the individual coils hence extend vertically, standardisation of the temperatures in operation is much better than in a transformer comprising superposed horizontal windings since in that case the individual coils are better cooled in the bottom of the transformer casing than in the upper part as the hot cooling oil in the casing tends to flow to the top whereas in transformers having the disclosed magnetic cores the coils, being vertical, are all in the same oil cooling conditions. Naturally, a difference in temperature would occur for any given coil between its upper part and its lower part but as copper has very good heat-conductivity and as the coil is not very high, that difference in temperature is negligible. Thus, regions of localised temperature increases are dispensed with.

The improved distribution of temperature enables the power to weight ratio of the transformer to be increased.

The shape of the yoke may be modified by giving it a circular, elliptical or polygonal shape other than a hexagonal shape. Moreover, the magnetic core could be constructed for a transformer other than a three-phase transformer, for example a six-phase transformer.

WHAT WE CLAIM IS:

1. A magnetic core for a polyphase transformer, comprising a plurality of sheets of core material which are arranged in stacked layers to provide a core structure, each layer comprising limbs radiating outwardly from an axis of the core extending in the direction of stacking and a yoke connecting the outer ends of the limbs, and the respective layers being formed by an assembly of abutting sheets so arranged that, for any two adjacent layers, no joint in either layer between abutting sheets coincides with any such joint in the other layer.

2. A core according to claim 1, wherein the sheets of each layer are coplanar and wherein each layer comprises an identical arrangement of sheets but the orientation of each arrangement about the said axis varies from one layer to another.

3. A core according to claim 2, wherein the orientation of consecutive layers progressively increases by 120°, each yoke, as viewed in the direction of stacking, being hexagonal and comprising six arms each comprising a sheet of core material.

4. A magnetic core for polyphase transformer, substantially as hereinbefore de-

scribed with reference to Figures 1 and 2 together with any one of Figures 7 to 9, or to Figures 3 and 4 together with any one of Figures 7 to 9, or to Figures 5 and 6 together with any one of Figures 7 to 9 of the accompanying drawings.

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FIG.1

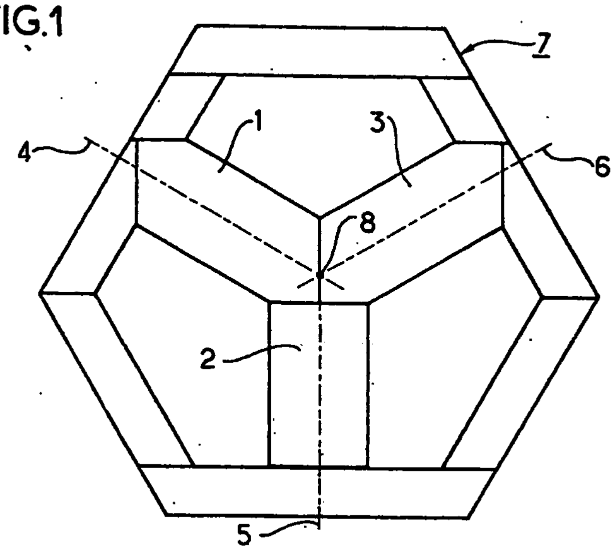


FIG.2

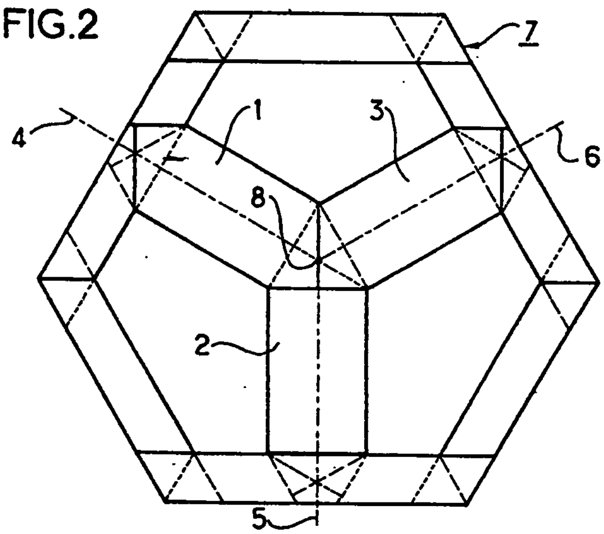


FIG. 3

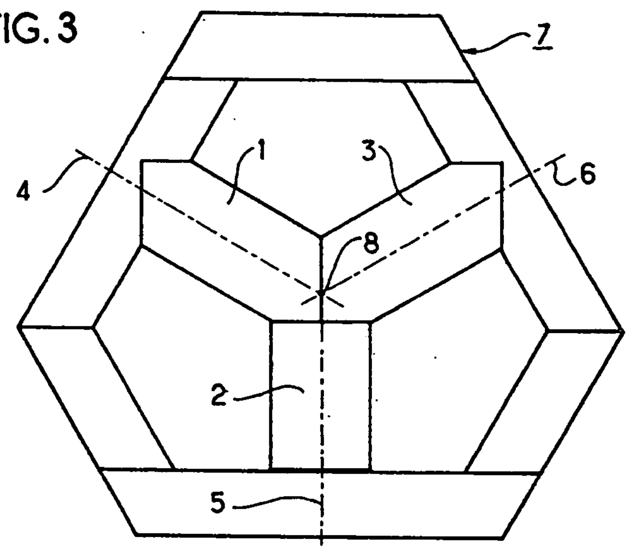


FIG. 4

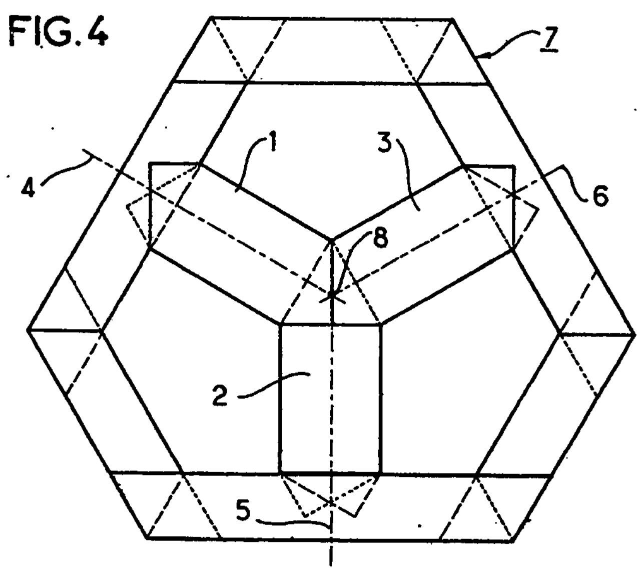


FIG. 5

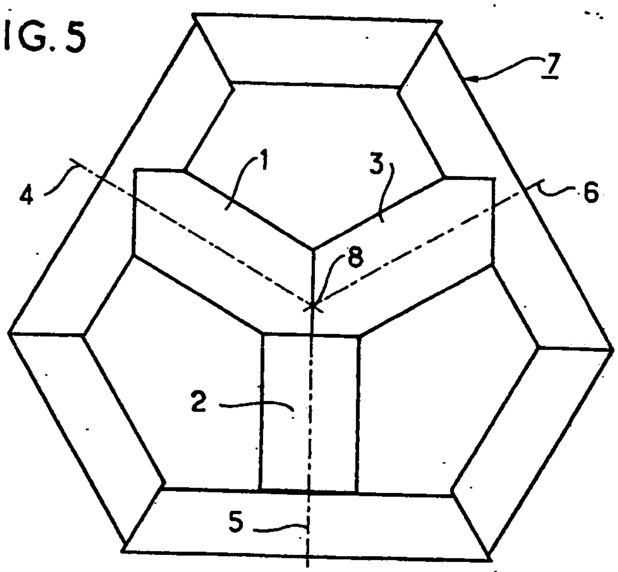


FIG. 6

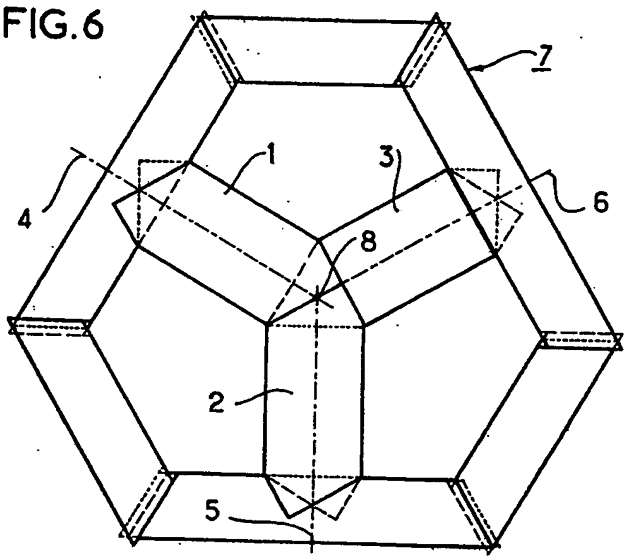
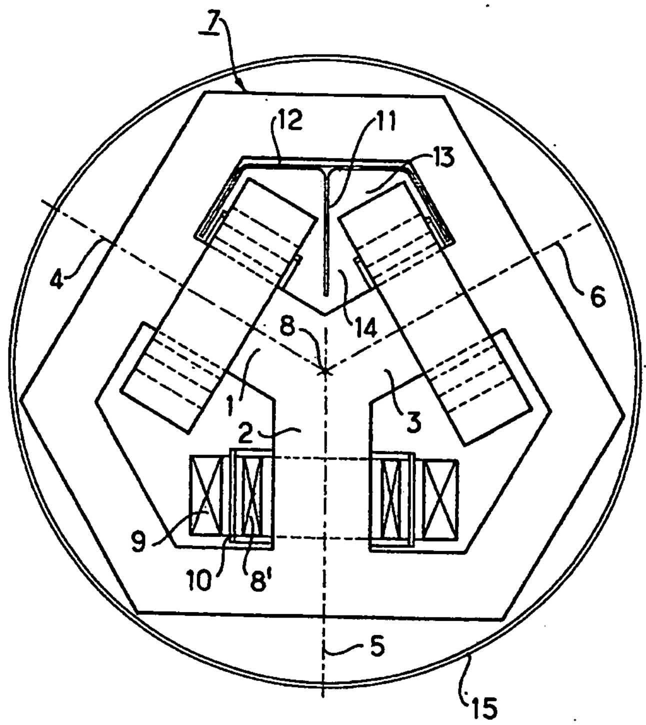


FIG. 7



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5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 5

FIG.8

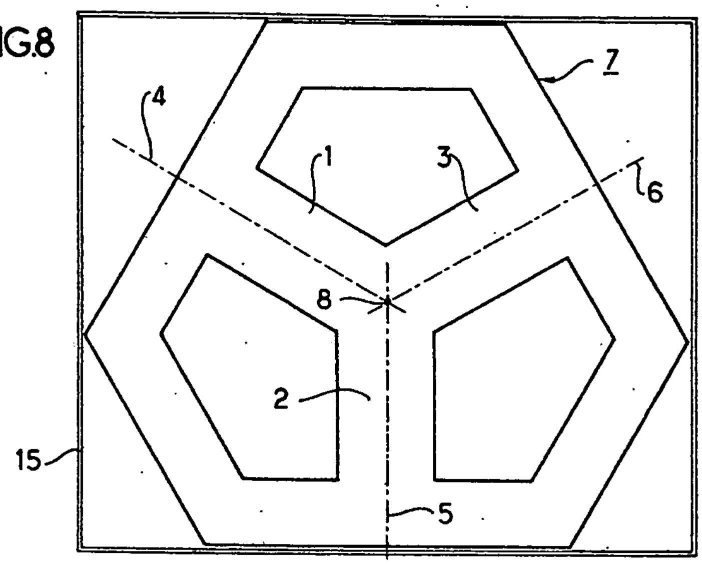

FIG.9